Decision Rationale
Total Maximum Daily Load
Phosphorus and Sediments
Conewago Creek Watershed
Dauphin, Lancaster, and Lebanon Counties, Pennsylvania
4/9/2001

I. Introduction

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the Total Maximum Daily Load (TMDL) for nutrients and sediment in the Conewago Creek watershed in Dauphin, Lancaster, and Lebanon Counties, Pennsylvania. TMDLs for sediment and phosphorus were developed for the Conewago Creek watershed. The document was submitted by the Pennsylvania Department of Environmental Protection (PADEP) for final Agency review, by letter dated March 2, 2001, and received by EPA on March 9, 2001. Our rationale is based on the TMDL document and information contained in Appendices to the document to determine if the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations (WLA) and load allocations (LA).
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Summary

The Conewago Creek watershed encompasses 53.2 square miles and covers areas of Dauphin, Lancaster, and Lebanon Counties, Pennsylvania. Land use in the watershed is dominated by agriculture (53%) with the remainder of the land divided between development and forested land uses. The entire basin, including its tributaries, is designated as a trout stocking fishery (TSF) as listed in 25 PA Code Chapter 93, Section 93.9o.

As a result of chemical sampling and an aquatic biological survey using kick-screen analysis and habitat surveys, PADEP included the 10 miles of the Conewago Creek basin on the 1996 Clean Water Act (CWA) section 303(d) list of water quality impaired waterbodies. TMDLs developed for waters listed in 1996 are for 10 miles of the main stem of Conewago Creek impaired by nutrients.

In 1998, changes in impaired stream mileage occurred to the previous listings due to PADEPs employment of a Geographic Information Systems (GIS) approach. The 1998 list includes 15.8 miles of the main stem of Conewago Creek (Segment ID 6432), 3.6 miles of an unnamed tributary (Segment ID 970701-0745-SAW), 11.2 miles of Lynch Run (Segment ID 970626-1200-SAW), and 5.7 miles of Hoffer Creek (Segment ID 970701-1035-SAW). Hoffer Creek and Lynch Run are tributaries of Conewago Creek. These segments were listed on the 1998 303(d) List because of impacts by nutrients and/or siltation due to agriculture.

Streams and the impairments addressed by the TMDLs for the Conewago watershed are listed in Table 1.

TABLE 1. WATERS FOR WHICH TMDLS WERE DEVELOPED IN THE CONEWAGO WATERSHED

STREAM NAME (STREAM CODE)	GIS KEY	MILES	YEAR LISTED	Source	Cause
Conewago (09217)	--	10.0	1996	Agriculture	Nutrients
Conewago (09217)	6432	15.8	1998	Agriculture	Nutrients
Conewago (09217)	6434*	0.9	1998	Agriculture	Organic Enrichment/Low D.O. and Suspended Solids
Conewago (09217)	970701-0745-SAW	5.1	1998	Agriculture	Habitat Alterations
Conewago (09217)	970701-0745-SAW	3.6	1998	Agriculture	Nutrients/Siltation
Hoffer Run (09267)	979701-1035-SAW	5.7	1998	Agriculture	Nutrients/Siltation/ Habitat Alterations
Lynch Run (09232)	970626-1200-SAW	11.2	1998	Agriculture	Siltation/Turbidity

* Listing for municipal point source. A TMDL was completed for discharger in 1998 for Ammonia Nitrogen to address criteria violations of ammonia toxicity in the stream.

Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls did not provide for attainment of water quality standards. These TMDLs were developed to address the impairments caused by excess sediment and nutrients in waters of the Conewago Creek basin. PADEP did not develop TMDLs listed on the 303(d) list in the category of 'flow alterations'. The impairments caused by 'flow alterations' are not due to excess concentrations of pollutants, but rather a change in flow regime. PADEP asserts that for these flow-related impairments, the development of a TMDL is not a suitable method to determine restoration needs. There is no pollutant for which the amount allowable to attain standards can be determined. EPA believes this to be consistent with current regulations as set forth in 40 CFR §130.7.

The Conewago Creek watershed was subdivided into two sub-basins, Sub-basin A and Sub-basin B, for TMDL model simulations of nutrients and sediment and for the purpose of finding suitable reference watersheds. The areas of these sub-basins are 28.7 and 24.4 square miles, respectively. Sub-basin A includes a portion of stream segment 09217 and segment 970701-1035-SAW. Sub-basin B includes a portion of stream segment 09217, and segments 970626-0830-SAW, 970626-1200-SAW, and 970701-0745-SAW. TMDLs for sediment and phosphorus were developed for each of the sub-basins. Table 2 summarizes the reductions in sediment and phosphorus required for waters in the Conewago Creek basin as determined by the TMDLs.

According to Federal regulations at 40 CFR §130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading**.** Table 2 summarizes the elements of the TMDLs for phosphorus and sediment developed by PADEP. Despite the fact that EPA believes that annual loads are an appropriate measure for these TMDLs, for the sake of consistency we are breaking the annual TMDL loads down into daily loads.

Table 2. Summary of TMDLs for the Conewago Creek watershed

Watershed	**Pollutant**	LA	WLA	MOS	TMDL		**% Reduction**
		lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/day	
Conewago Creek Sub-basin A	Phosphorus	2,853	1,217	452	4,522	12	47%
	Sediment	2,811,165	0	312,352	3,123,517	8,558	54%
Conewago Creek Sub-basin B	Phosphorus	6,487	821	812	8,120	22	45%
	Sediment	5,791,202	0	643,467	6,434,669	17,629	34%

The TMDL is a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards. The TMDL is a scientifically-based strategy which considers current and foreseeable conditions, the best available data, and accounts for uncertainty with the inclusion of a 'margin of safety' value. Conditions, available data, and the understanding of the natural processes can change more than anticipated by the margin of safety. The option is always available to refine the TMDL for re-submittal to EPA for approval. The unassessed waters protocol, a method of conducting biological assessments of Pennsylvania's waters, was developed in 1996 and began implementation in 1997. PADEP's goal is to achieve a comprehensive, statewide assessment of surface waters in Pennsylvania. After completion of the initial assessments, the long-range goal is to reassess all waters on a five-year cycle. Therefore, while the TMDL should not be modified at the expense of achieving water quality standards expeditiously, the TMDL may be modified when warranted.

III. Discussion of Regulatory Conditions

EPA finds that Pennsylvania has provided sufficient information to meet all of the eight basic requirements for establishing phosphorus and sediment TMDLs for tributaries in the Conewago Creek basin. EPA therefore approves the TMDLs and information contained in the appendices for phosphorus and sediment in the Conewago Creek basin. EPA's rationale for approval is set forth according to the regulatory requirements listed below.

1) The TMDLs are designed to implement the applicable water quality standards.

Water Quality Standards consist of three components: designated and existing uses; narrative and/or numerical water quality criteria necessary to support those uses; and an anti-degradation statement. The designated use of the entire Conewago Creek basin is trout stocking fishery (TSF). Pennsylvania does not currently have numeric water quality criteria for nutrients (nitrogen or phosphorus) or sediments. Therefore, Pennsylvania utilized its general water quality criteria, which state that "water may not contain substances attributable to point or non-point source waste discharges in concentrations or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant, or aquatic life"[1], to establish an endpoint for phosphorus and sediment such that the designated uses of the Conewago Creek watershed are attained and maintained.

In order to numerically express this endpoint consistent with the general water quality criteria, PADEP uses a Reference Watershed approach in combination with the AVGWLF[2] watershed loading model. The reference watershed is representative of the conditions required for the impaired watershed to meet its designated uses. This representative condition is analyzed to determine an appropriate level of nutrient and sediment loading to the waterbody. The Reference Watershed approach consists of comparing the biologically-impaired watershed with a reference watershed that is meeting its designated uses for aquatic life to determine an appropriate level of nutrient and sediment loading to the waterbody. The impaired watershed and the reference watershed have similar designated water uses, geology, land uses, physiographic province, land area, soils, and meteorological patterns. The AVGWLF model provides a powerful and accurate means of estimating the dissolved and total nutrient loadings to a stream from complex watersheds with added GIS capabilities. The model provides monthly stream flow, soil erosion, and sediment yield values and includes both surface runoff and groundwater sources as well as nutrient loads from point sources and onsite wastewater disposal (septic) systems[3]. Calibration of this model is not required, however, it has been applied and validated to an 85,000 hectare watershed in upstate New York. The rationale of this method is that achieving nutrient and sediment loadings in the impaired watershed similar to those loadings of the reference watershed will ensure that the impaired watershed will attain and maintain its designated uses and general water quality criteria.

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[1] Pennsylvania Code, Title 25., Environmental Protection, Chapter 93. Water Quality Standards, Section 93.6(a).

[2] Arcview Generalized Watershed Loading Function model, the Environmental Resources Research Institute of Pennsylvania State University's Arcview based version of the GWLF model developed by Cornell

[3] Haith, D.A., R. Mandel and R.S. Wu, Generalized Watershed Loading Functions, Version 2.0, Cornell University, Dec. 15, 1992.

The Lehman-Muddy Run watershed is used as the reference watershed for comparison with the Conewago Creek Sub-basin A watershed sediment and phosphorus TMDLs. The Little Swatara Creek sub-watershed is used as the reference watershed for the sediment and phosphorus TMDLs in the Conewago Creek Sub-basin B watershed. Further ground truthing of both the reference and the impaired watersheds in preparation for TMDL development resulted in adjustments of model parameters in the impaired Conewago watershed to account for the difference in cattle access to the streams. Table 3 below compares these watersheds. EPA finds the use of the Lehman-Muddy Run and Little Swatara Creek watersheds as reference watersheds to be reasonable for these TMDLs.

Table 3. Comparison Between Conewago Subwatersheds and Reference Watersheds

ATTRIBUTE	CONEWAGO		REFERENCE	
	SUBBASIN A	SUBBASIN B	LEHMAN-MUDDY RUN	LITTLE SWATARA CREEK
Physiographic Province	Piedmont	Piedmont	Ridge and Valley	Ridge and Valley
Area (square miles)	27.8	24.4	24.6	22.2
Predominant Land Use				
Agriculture (%)	48	59	52	55
Predominant Geology				
Shale (%)	69	74	93	80
Average Precipitation (in)	41.1	41.6	39.0	41.2

Using the continuous simulation AVGWLF model, PADEP modeled the nutrient and sediment loads originating from nonpoint sources in the reference watersheds. As previously mentioned, AVGWLF has the ability to estimate dissolved and total monthly nutrient loads to streams from watersheds including surface runoff, groundwater sources, point sources, septic systems, monthly streamflow, soil erosion, and sediment yield values. In order to make these estimates, AVGWLF requires daily precipitation and temperature data, runoff sources and transport and chemical parameters. The AVGWLF model is a combined distributed/lumped parameter watershed model. In terms of surface loading, this means that the model allows the user to distribute multiple land use/cover scenarios in the watershed, however, the loads originating from the watershed are lumped and spatial routing of nutrient and sediment loads is not available. In terms of sub-surface loading, the load contributions from sub-surface areas are not distinct and are considered lumped using a water balance approach. The AVGWLF model relies on the Soil Conservation Service Curve Number (SCS-CN) to estimate surface runoff and the Universal Soil Loss Equation (USLE) to estimate erosion and sediment yield. Monthly estimates of nutrient and sediment loadings, applicable to each watershed, are generated by using watershed specific local daily weather inputs and USLE factors[4]. The following average

[4] Local daily weather inputs include temperature and precipitation. The USLE factors are KLSCP;

existing load values for sediment, illustrated in Table 4, were determined for the Lehman-Muddy Run, Little Swatara Creek, Conewago Creek Sub-basin A, and Conewago Creek Sub-basin B watersheds using watershed specific data**.**

Table 4. Existing sediment loading values for the reference watersheds and the Conewago Creek watershed

	Area (Acres)	Sediment Load lbs/yr	Unit Area Sediment Loading Rate lbs/acre/yr
Lehman-Muddy Run Watershed	15,407	2,660,737	173
Conewago Creek Sub-basin A Watershed	18,087	6,154,085	340
Little Swatara Creek Watershed	13,934	5,851,910	420
Conewago Creek Sub-basin B Watershed	15,321	8,784,364	573

Table 5 illustrates the average existing load values for phosphorus as determined for the reference watersheds and the Conewago Creek watershed using watershed specific data.

Table 5. Existing phosphorus load values for the reference watersheds and the Conewago Creek watershed

	Area (Acres)	Total Phosphorus lbs/year	Unit Area P Loading Rate lbs/acre/yr
Lehman-Muddy Run Watershed	15,407	3,872	0.25
Conewago Creek Watershed Sub-basin A	18,087	7,652	0.42
Little Swatara Creek Watershed	13,934	7,338	0.53
Conewago Creek Watershed Sub-basin B	15,321	13,201	0.86

Although both nutrients (phosphorus and nitrogen) are listed as the causes of impairment and are subsequently modeled, only a TMDL for phosphorus is being established to help restore the designated uses of the Conewago Creek basin. This is due to PADEP's finding that phosphorus is the limiting nutrient in all waters of the Conewago Creek basin. Phosphorus is often the major nutrient in shortest supply and is frequently a prime determinant of the total biomass[5]. It is also

K=changes in soil loss erosion, LS=length slope factor, C=vegetation cover factor, P=conservation practices factor.

[5] U.S. EPA. 1980. Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients. EPA 440/5-80-011.

the most effectively controlled using existing engineering technology and land use management[6]. EPA finds this to be a reasonable determination.

The final step in the process is to determine the appropriate pollutant loading for each water. For Sub-basin A of the Conewago Creek watershed the values generated for sediment and phosphorus loading were based on those found in the reference Lehman-Muddy Run watershed. To determine the nutrient and sediment reductions for Sub-basin B of the Conewago Creek basin, values generated for sediment and phosphorus were based on those in the Little Swatara Creek reference watershed.

In the process of determining the total phosphorus and sediment loadings in the reference watersheds, a unit area loading coefficient for the parameter of concern was calculated. Those aerial loading coefficients were applied to the Conewago Creek watershed to determine the allowable (TMDL) sediment and phosphorus loadings. EPA finds this application reasonable to implement the applicable water quality standards.

Table 6 illustrates the sediment TMDL calculations. The target TMDL value for sediment is determined by multiplying the unit area loading value of the reference watershed by the total area in acreage of the impaired watershed.

Table 6. Sediment TMDL calculations

Watershed	Unit area loading rate in Reference Lehman-Muddy Run (lbs/acre/year)	Total watershed area in Impaired Conewago Creek Subbasin A (acres)-	TMDL value for sediment (lbs/year)
Conewago Creek Sub-basin A	172.96	18,087.42	3,123,517
	Unit area loading rate in Reference Little Swatara Creek (lbs/acre/year)	Total watershed area in Impaired Conewago Creek Sub-basin B (acres)	TMDL value for sediment (lbs/year)
Conewago Creek Sub-basin B	420	15,320.64	6,434,669

Table 7 illustrates the phosphorus TMDL calculations. The target TMDL value for phosphorus is determined by multiplying the unit area loading value of the reference watershed by the total area in acreage of the impaired watershed.

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[6] Id.

Table 7. Phosphorus TMDL calculations

Watershed	Unit area loading rate in Reference Lehman-Muddy Run watershed (lbs/acre/year)	Total watershed area in impaired Conewago Creek Sub-basin A (acres)	TMDL value for phosphorus (lbs/year)
Conewago Creek Sub-basin A	0.25	18,087.42	4,522
	Unit area loading rate in Reference Little Swatara Creek watershed (lbs/acre/year)	Total watershed area in impaired Conewago Creek Sub-basin B (acres)	TMDL value for phosphorus (lbs/year)
Conewago Creek Sub-basin B	0.53	15,320.64	8,120

2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocation.

Tables 2, 6, and 7 indicate the total allowable loads for phosphorus and sediment as determined using the Reference Watershed approach and the AVGWLF model.

<u>A. Waste Load Allocations</u>

Pennsylvania indicates that there are no known point source discharges of sediment in the Conewago Creek watershed. Therefore, the WLA is set at zero for the sediment TMDLs.

Pennsylvania indicates that in the Conewago Creek Sub-basin A watershed, one point source is currently discharging into the creek. There are three point source dischargers in the Conewago Creek Sub-basin B watershed.

The phosphorus contributions from the four point source facilities were considered in the TMDL computations. In determining the current contribution of phosphorus loading from the point sources to the Conowago Creek watershed, the model parameters were adjusted to account for existing contributions based on current discharge monitoring reports. This allows the model to determine the contributions from the sources of the pollutants based on actual current conditions. In determining the WLA, however, the maximum permitted load for the point source dischargers is used. This ensures that the TMDL can still be met even if the discharger increases his load from the current levels to the permit levels. The WLA for Sub-basin A is set equal to the maximum permit limit of the Mt. Gretna discharger, with no reductions assigned. The WLA for Sub-basin B is set equal to the sum of the maximum permit limits of the three point source facilities located in Sub-basin B (Cedar Manor Mobile Home Park, Conewago Valley Motor Inn, and Conewago Industrial Park) with no reductions assigned. EPA finds that point source discharges have been adequately accounted for in these TMDLs.

B. Load Allocations

The TMDLs include LAs for nonpoint sources. According to federal regulations, 40 CFR §130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. The AVGWLF process enables the LA to be distributed to sources based on land use type.

The process of allocating phosphorus and sediment loads to distinct land uses in the Conewago Creek basin begins by subtracting 10% from the TMDL value for the margin of safety. For example, the allocable load for sediment in the Conewago Creek Sub-basin A watershed of 3,123,517 lbs/year is reduced by 312,352 lbs/year to 2,811,165 lbs/year (3,123,517 lbs/year x 0.1 = 312,352 lbs/year). The allocable load for phosphorus for Sub-basin A and for sediment and phosphorus for Sub-basin B each also reduced by 10% to allow for a margin of safety. See below for further discussion on the application of a margin of safety in TMDLs.

As discussed earlier, load allocations for phosphorus were determined by multiplying the unit area loading rate for phosphorus of the reference Lehman-Muddy Run and Little Swatara watersheds by the total area in each of the Sub-basins (A and B) of the Conewago Creek watershed. These reductions were then applied and distributed individually to each of the watersheds of the seven listed segments. Load allocations for sediment were determined by multiplying the unit area loading rate of the reference Lehman-Muddy Run and Little Swatara watersheds by the total area of the impaired Conewago Creek Sub-basins A and B, respectively. These reductions were then applied and distributed individually to the sub-watersheds of the seven listed segments within the Conewago Creek watershed. These allocation units include the four segments of the main stem of Conewago Creek, Hoffer Run, and Lynch Run.

To determine the distribution of the sediment and/or phosphorus load allocation between contributing land based sources, PADEP uses a method called the Equal Marginal Percent Reduction (EMPR)[7]. This method equitably assigns the greater reduction requirements to the largest contributing source. Table 8 shows the load allocations of sediment in the Conewago Creek Sub-basin A watershed. The table shows the overall average reductions in sediment for each land use and is useful in demonstrating the EMPR method employed by PADEP to distribute the allocable loads of phosphorus and sediment in these TMDLs.

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[7] Pennsylvania Department of Environmental Protection. June 1986. Implementation Guidance for the Water Quality Analysis Model 6.3. Document 391-2000-007.

Table 8. Summary of load allocations for sediment in the Conewago Creek Sub-basin A watershed

Land Use	Sediment (lbs/yr)						
	Acres	Existing Load	Baseline Reduction	Baseline Load	EMPR Reduction	TMDL Load Allocation	% Reduction
Hay/pasture	3,064	352,346	0	352,346	43,340	309,006	12.3
Cropland	5,572	5,502,731	2,990,574	2,512,157	309,006	2,203,151	60.0
Coniferous	275	1,909	0	0	0	1,909	0
Mixed Forest	346	1,943	0	0	0	1,943	0
Deciduous	8,584	268,909	0	0	0	268,909	0
Low Intensity Development	185	14,162	0	0	0	14,162	0
High Intensity Development	61	12,085	0	0	0	12,085	0
Total	18,087	6,154,085	2,990,574	2,864,503	352,346	2,811,165	54.3

The total allocable load of sediment is 2,811,165 lbs/year after subtracting the margin of safety value. The EMPR method is then used to distribute the remaining sediment load and works in the following manner. PADEP allocated certain land use loadings similar to their existing loads. In the Conewago Creek watershed, those land uses are forested, low intensity development, and high intensity development. Reasons that the loads for these land use types remain constant include an extremely limited ability to affect the sediment loading processes or insufficient reasonable assurance to make substantial reductions. This is appropriate because sediment loading from forested lands represents the natural condition which would be expected to exist. It was appropriate to make these allocations for low intensity development and high intensity development because these loads are small in comparison to the total loading and would not significantly improve water quality even if completely eliminated. Therefore, the allocable load for sediment of 2,811,165 lbs/yr is further reduced by 299,008 lbs/yr to 2,512,157 lbs/yr. The value of 299,008 lbs/yr is the sum of the sediment load from low intensity development (14,162 lbs/yr), high intensity development (12,085 lbs/yr), deciduous forest (268,909 lbs/yr), mixed forest (1,943 lbs/yr) and coniferous forest (1,909 lbs/yr). The remaining "active land use" current loads (hay/pasture and cropland) are then compared with the remaining allocable load of 2,512,157 lbs/yr to determine if any one contributor would exceed this load by itself. If the remaining allocable load is exceeded by any land use, it will be reduced to the allocable load value of 2,512,157 lbs/yr. If the allocable load is not exceeded, the existing load becomes the baseline load. In Table 7, only the 'cropland' land use with an existing load of 5,502,731 lbs/yr exceeds this value. Therefore, 'cropland' is reduced to 2,512,157 lbs/yr, which becomes the baseline load. The actual value of the reduction is represented in the 'Baseline Reduction' column of Table 8. The baseline loads are then summed to determine the equal percent reduction that must occur in the "active land uses" to achieve the allocable load value of

2,512,157 lbs/yr. The total baseline load is 2,864,503 lbs/yr, which must be reduced approximately 12.3 percent to equal 2,512,157 lbs/yr. This reduction can be seen in the 'EMPR Reduction' column of Table 8, which is then subtracted from the baseline load value to determine the TMDL load allocation value for each land use.

This same method was used to determine the phosphorus reductions in each of the sub-watersheds. EPA finds that PADEP appropriately applied the EMPR method for phosphorus and sediment in the Conewago Creek watershed TMDLs. According to federal regulations at 40 CFR §130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. While it is not necessary to specifically approve an allocation method, EPA believes that the EMPR method used by PADEP is acceptable because it supports three main objectives; 1) to assure compliance with the applicable water quality standard, 2) to minimize the overall cost of compliance and, 3) to provide maximum equity among competing discharges.

3) The TMDLs consider the impacts of background pollutant contributions.

The state has included natural background as a component of the load allocations, as required by 40 CFR §130.2(g). There are two separate considerations of background pollutants within the context of these TMDLs. First, there is the inherent assumption of the Reference Watershed approach that because of the similarities between the reference and impaired watershed, the background pollutant contributions will be similar. Therefore, the background pollutant contributions will be considered when determining the loads for the impaired watershed which are consistent with the loads from the reference watershed. Secondly, the AVGWLF model implicitly considers background pollutant contributions through the groundwater component of the model process.

4) The TMDLs consider critical environmental conditions.

EPA regulations at 40 CFR §130.7(c)(1) require TMDLs to take into account critical conditions for streamflow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Conewago Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards.[8] In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. Critical conditions are the combination of environmental factors (e.g., flow, temperature) that results in attaining and

[8] EPA Memorandum regarding EPA Actions to Support High Quality TMDLS from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Water Management Division Directors, August 9, 1999.

maintaining the water quality criterion and has an acceptably low frequency of occurrence. For example, stream analysis often uses a low-flow (7Q10) design condition as critical because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.
Within the context of the Reference Watershed approach, the assumption is that the reference watershed is achieving its designated use even during critical environmental conditions. Thus, achieving sediment and/or phosphorus loadings in the impaired watershed consistent with that of the reference watershed will effectively consider critical conditions. To account for different flow conditions, the AVGWLF model uses daily average temperature, daily time step and total precipitation values for each year simulated. PADEP modeled each watershed for a period of up to 20 years to develop the existing loading values for each watershed. The length of the model time period will also effectively consider critical environmental conditions. EPA finds that Pennsylvania adequately considered critical conditions in the TMDL analysis of the Conewago Creek basin.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in streamflow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flow normally occurs during the colder period of winter and in early spring from snowmelt and spring rain, while seasonally low flow typically occurs during the warmer summer and early fall drought periods[9]. The model considers seasonal changes requiring specifications of the growing season, hours of daylight for each month, the months in which manure is applied to the land and by using daily time steps for weather data and water balance calculations. EPA finds that both the AVGWLF model and the assumptions of the Reference Watershed approach effectively consider seasonal environmental variations.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. Margins of safety (MOS) may be implicit, built into the modeling process, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL.

PADEP reserves 10% of the TMDL value for both phosphorus and sediments as the margin of safety. This accounts for uncertainty in the data and computational methodology used in the analysis. Table 2 indicates the actual value of the MOS for each TMDL. EPA finds this explicit MOS acceptable.

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[9] U.S. EPA. 1997. Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1, Section 2.3.3. EPA 823-B-97-002.

7) There is reasonable assurance that the TMDLs can be met.

The proposed reductions in phosphorus and sediment loadings all come from agricultural areas. PADEP believes that the implementation of BMPs throughout the Conewago Creek watershed will allow the TMDL to be achieved.

The pollutant reductions in the TMDLs are allocated entirely to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected areas should achieve the loading reduction goals established in the TMDLs. Substantial reductions in the amount of sediment reaching the streams can be made through the planting of riparian buffer zones, contour strips, and cover crops. These BMPs range in efficiency from 20% to 70% for sediment reduction. Implementation of BMPs aimed at sediment reduction will also assist in the reduction of phosphorus. Additional phosphorus reductions can be achieved through the installation of more effective animal waste management systems and stone ford cattle crossings. Other possibilities for attaining the desired reductions in phosphorus and sediment include streambank stabilization and fencing. Further ground truthing should be performed in order to assess both the extent of existing BMPs in the Conewego Creek Watershed, and to determine the most cost-effective and environmentally protective combination of BMPs required to meet the nutrient and sediment reductions outlined in this TMDL.

Funding assistance for the types of projects described above includes Pennsylvania’s Growing Greener funding which has provided more than $65 million dollars to environmental initiatives through out the Commonwealth. Additionally, annual Section 319 grant funding, supported by the Unified Watershed Assessment and the Watershed Restoration Action Strategies, is designed to focus resources towards the implementation of Best Management Practices for non-point source pollutants. Pennsylvania has staffed watershed coordinators in each Regional office who are available to provide grant application assistance to stakeholders as well as technical assistance on the installation of management practices.

8) The TMDLs have been subject to public participation.

Pennsylvania published a notice of availability for the Conewago Creek basin TMDLs for public review and comment in the *Pennsylvania Bulletin* and the *Lancaster Intelligencer*. A public meeting was held on January 25, 2001 at the Farm and Home Center in Lancaster, Pennsylvania.

Comments were received during the public meeting and in writing. The organizations that submitted written comments include the Mid-Atlantic Environmental Law Center, U.S. EPA, Pennsylvania Builders Association, and the U.S. Fish and Wildlife Service. Responses from PADEP to those comments were provided in the TMDL submittal. EPA finds that PADEP has addressed comments on the Conewego Creek TMDL and has conducted adequate public participation.